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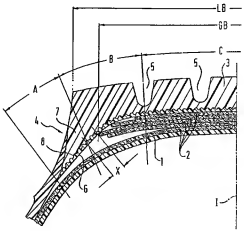
## (54) Pneumatic vehicle tyre.

(57) A pneumatic vehicle tyre comprising a carcass (1), at least one breaker layer (2) which is disposed radially outside of the carcass and which is embedded in rubber or rubber-like material and a protector (4) which has a tyre tread (3), which covers over the remaining tyre parts (1,2) towards the outside, which is made of rubber or rubber-like material and which, at least from tyre shoulder to tyre shoulder, is made of two connected parts, namely a radially inner lying lower part (6) of the protector and a radially outer lying upper part (7) of the protector, wherein, in order to reduce the likelihood of detachment of the two protector parts (6,7) occurring, the interface (8) between the upper part (7) and the lower part (6) of the protector has a wave-shaped form, at least in some sections, with the crests and the troughs of the waves extending in the peripheral direction of the tyre.

Fig.1

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The invention relates to a pneumatic vehicle tyre comprising a carcass, at least one breaker layer which is disposed radially outside the carcass and which is embedded in rubber or rubber-like material and a protector which has a tyre tread, which covers the remaining tyre parts and is towards the outside, is made of rubber or rubber-like material and which, at least from tyre shoulder to tyre shoulder, is made of two connected parts, namely a radially inner lying lower part of the protector and a radially outer lying upper part of the protector.

Modern pneumatic vehicle tyres need to satisfy a large number of physical requirements, in particular having regard to loads at high speeds and carrying loads over sustained periods. The construction of the tyre must provide a certain stability of form and avoid detachment or delamination effects as a result of loads and fatigue.

A tendency to detach in this way takes place in particular in the transition region between the upper and lower parts of the protector where lateral forces can lead to a shearing off of the two protector parts. Centrifugal forces can then lead to separation in the radial direction.

The object of the invention is therefore to modify a pneumatic vehicle tyre of the initially named kind, such that separation of the lower part and the upper part of the protector is avoided to the greatest possible extent.

This object is satisfied by providing the interface between the upper part and the lower part of the protector with a wave-shaped form, at least in some sections, with the crests and the troughs of the waves extending in the peripheral direction of the tyre.

The design of the interface in accordance with the invention enlarges the connecting area between the upper and lower parts of the protector compared to a planar interface and, furthermore, provides a form-locked connection between the upper and lower parts of the protector which counteracts shearing off of the two protector parts relative to one another. In this manner, a connection between the two protector parts is provided which is significantly stronger than for known pneumatic vehicle tyres with two-part protectors with planar interfaces.

The waves of the interface preferably have an approximately sinusoidal or approximately trapezoidal form. A sinusoidal form provides a maximum connection area between the upper and lower parts of the protector. A trapezoidal form provides a large connection surface in an advantageous manner which is simple to manufacture.

In accordance with an embodiment of the invention, the wave form and/or the wavelength and/or amplitude of the wave can be different transverse to the peripheral direction of the tyre. This allows different requirements to be met in different regions of the pneumatic vehicle tyre.

In particular, in accordance with an embodiment of the invention, the tyre is sub-divided transversely to the peripheral direction into three regions having different forms of interface between the upper and lower parts of the protector, namely a central region, a first shoulder region on either side of the central region and a shoulder region on either side of the first shoulder region, wherein the central region preferably has a width of approximately 0.44-0.62 times the tread width, with the first 'shoulder region extending beyond both lateral ends of the breaker layers of the breaker in each case via a length of between approximately 5 to 20mm, and with the second shoulder region extending in each case up to the end of the two-part region of the protector. This defines three regions which are different from one another in respect of their requirements on the transition region between the upper and lower parts of the protector.

In the central region, in which the transition between the upper and lower parts of the protector extends approximately in a plane, the requirements are determined in particular by the tyre deformation when running fast. In the first shoulder region, the transition between the upper and lower parts of the protector has an arched shape and bending moments thus arise which represent a load for the connection surface between the upper and lower parts of the protector. Finally, the second shoulder region has the lowest requirements since the transition region between the upper and lower parts of the protector extends approximately in a plane and only slight deformations of the vehicle tyre occur in this region.

The waves in the first shoulder region thus preferably have an approximately sinusoidal form and the waves in the second shoulder region as well as in the central region preferably have an approximately trapezoidal form, since in the first shoulder region a maximum connection surface is required, whereas in the two other regions an interface of trapezoidal waves is often sufficient and thus allows the simple-to-manufacture trapezoidal form to be selected.

In order to achieve a further increase in the connection area between the upper and lower parts of the protector, the wavelength can be reduced and/or the amplitude of the wave of the interface increased - in particular in the first shoulder region. It is thus preferred to select the wavelength in the central region and in the second shoulder region to be larger than in the first shoulder region.

The smallest thickness of the lower part of the protectors, i.e. the distance between the base of the wave and the radially inner lying delimiting surface of the lower part of the protector, can be the same over the entire tyre or, in accordance with a preferred embodiment of the invention, can vary transversely to the peripheral direction of the tyre. In particular, the smallest thickness of the lower part of the protector can amount to approximately 1.5mm in the central re-

gion, to approximately 2.5mm in the first shoulder region and to approximately 1mm in the second shoulder region. This achieves a reliable and secure performance of the protector with a minimum amount of material and weight.

In accordance with a further embodiment of the invention, the upper part of the protector has a dynamic modulus E* of approximately 5 to 8 MPa and a Shore hardness of approximately 60 to 70 ShA and, furthermore, the lower part of the protector has a dynamic modulus E* of approximately 4 to 6 MPa and a Shore hardness of approximately 55 to 65 ShA. These values achieve a secure and reliable performance of the protector.

The invention is described in the following by means of example only with the aid of an embodiment and the Figures which show:

Figure 1 a partial section through a first variant of a pneumatic vehicle tyre of the invention;

Figure 2 a partial section through a second variant of a pneumatic vehicle tyre of the invention;

Figure 3 a partial section through a third variant of a pneumatic tyre of the invention; and

Figure 4 a schematic illustration of the transition region between the upper and lower parts of the protector.

The pneumatic vehicle tyre of the invention illustrated in Figures 1 to 3 is constructed mirror symmetrically with respect to the axis I. The tyre comprises a carcass 1, a breaker arranged radially on top of the carcass which is made up of a plurality of breaker plies 2, and a protector 4 bearing the tread 3 of the tyre. Carcass 1 and breaker plies 2 are surrounded by rubber material and are closed off to the outside by the protector 4 which is also made of rubber. Grooves 5 are provided in the tread 3 which form the tread pattern or profile of the pneumatic vehicle tyre.

The protector 4 is constructed in two parts between the two shoulder regions of the tyre and has a radially inner lying lower part 6 and a radially outer lying upper part 7. The respective parts 6 and 7 of the protector are separated from one another by a wave-shaped interface 8. The waves of the interface 8 extend longitudinally in the peripheral direction of the tyre which lies perpendicular to the plane of the drawing.

Three regions A, B and C are indicated in each of the Figures 1 to 3. These regions divide the vehicle tyre up transversely to its peripheral direction. A central region C extends approximately 0.44 to 0.62 times the width LB of the tread (see Figure 1). A first shoulder region B is then connected on either side thereof and, in turn, a second shoulder region A extends axially from each of those. The first shoulder region B extends from the central region C up to approximately 5 to 20mm beyond the lateral limit of the breaker plies 2 of the breaker, the breaker having a breaker width GB of approximately 0.72 to 1 times the width LB of tread. The second shoulder region A extends from the end of the first shoulder region B as far as the protector 4 has a two-part construction.

In the variant of Figure 1, the interface 8 has a sinusoidal form in all three regions A, B and C, whereas in the variant of Figure 2 the interface 8 has a sinusoidal form in the two shoulder regions A and B and a trapezoidal form in the central region C. Finally, in the variant of Figure 3, the interface has a trapezoidal form in the two shoulder regions A and B but has a sinusoidal form in the central region C. This design is advantageous for very pronounced loading in the central region of the tread 3. Naturally, other combinations of the interface form in the three regions A, B and C are possible. A combination may also be possible in which a non-wave-shaped region is present, i.e. in a region of lesser load, the interface 8 can also be formed planar.

The meaning of the term smallest thickness d of the lower part 6 of the protector is apparent from the schematic illustration of Figure 4. Similarly, the meaning of amplitude and wavelength of the sinusoidally and trapezoidally shaped waves of the interface 8 are also evident. Whereas in the illustrated embodiment, the amplitude "a" of the two wave forms is the same, the wavelength $1_1$ of the sinusoidally shaped wave is smaller than the wavelength $1_2$ if the trapezoidally shaped wave.

The size of the connection surface between the lower and upper parts 6 and 7 of the protector can be adjusted as required by varying the wavelength and amplitude. The amplitude of the wave preferably amounts to approximately 1 to 2mm, the wavelength 11 of the sinusoidally shaped wave to approximately 1 to 2 times the amplitude and the wavelength $1_2$ of the trapezoidally shaped wave to approximately 2 to 3 times the amplitude.

Similarly, the smallest thickness d can be selected to match the requirements and can in particular be varied transversely to the peripheral direction of the tyre. The smallest thickness d in the central region C can preferably amount to approximately 1.5mm, in the first shoulder region B to approximately 2.5mm, and in the second shoulder region to approximately 1mm.

The material for the protect is preferably selected so that the upper part of the protector has a dynamic modulus E* of approximately 5 to 8 MPa and a Shore hardness of approximately 60 to 75 ShA and so that the lower part of the protector has a dynamic modulus E* of approximately 4 to 7 MPa and a Shore hardness of approximately 55 to 65 ShA.

The upper and lower parts of the protectors 6 and 7 respectively are joined or adhered together in a conventional manner during the manufacture of the vehicle tyre, the manufacture also being possible in a conventional manner.

As a result of the design of the interface between

the lower part 6 and the upper part 7 of the protector in accordance with the invention, a large connection surface is provided for the joining of the two protector parts. Simultaneously, an intermeshing is provided by the wave form, by means of which a kind of form-locked connection is achieved between the lower part 6 and the upper part 7 of the protector. This intermeshing prevents mutually opposing shear force contributions acting on the two protector parts 6 and 7 on either side of the interface 8 from summing together in an undesirable manner.

The largest connection surface is achieved by a sinusoidally shaped wave. However, the manufacture of such a wave is more difficult than that of a trapezoidally shaped wave. In any case, care should be taken to avoid small angles in the wave form since these can lead to material rupture. Account can also be taken of the profile design in the choice of a suitable form for the interface 8 to the extent that it influences the solidity of the connection between the upper and lower parts of the protector.

## Claims

1. A pneumatic vehicle tyre comprising a carcass (1), at least one breaker layer (2) which is disposed radially outside of the carcass and which is embedded in rubber or rubber-like material and a protector (4) which comprises a tyre tread (3), which covers over the remaining tyre parts (1,2) towards the outside, which is made of rubber or rubber-like material and which, at least from tyre shoulder to tyre shoulder, is made of two connected parts, namely a radially inner lying lower part (6) of the protector and a radially outer lying upper part (7) of the protector, characterised in that the interface (8) between the upper part (7) and the lower part (6) of the protector has a wave-shaped form, at least in some sections, with the crests and the troughs of the waves extending in the peripheral direction of the tyre.

2. A pneumatic vehicle tyre in accordance with claim 1, characterised in that the waves of the interface (8) have an approximately sinusoidal form.

3. A pneumatic tyre in accordance with claim 1, characterised in that the waves of the interface (8) have approximately a trapezoidal form.

4. A pneumatic vehicle tyre in accordance with any one of the preceding claims, characterised in that the wave form and/or wavelength (1) and/or wave amplitude (a) and/or smallest thickness (d) of the lower part (6) of the protector transverse to the peripheral direction of the tyre are different.

5. A pneumatic vehicle tyre in accordance with claim 4, characterised in that the tyre is subdivided transversely to its peripheral direction into three regions (A,B,C) having different forms of interface (8) between the upper part (7) and the lower part (6) of the protector, namely a central region (C), a first shoulder region (B) on either side of the central region (C) and a second shoulder region (A) on either side of the first shoulder region (B), wherein the central region (C) preferably has a width of approximately 0.44 to 0.62 times the tread width (LB), with the first shoulder region (B) extending beyond both lateral ends of the breaker layers (2) of the breaker in each case by a length (X) of between approximately 5 to 20mm, wherein the breaker layer has a breaker width GB of approximately 0.72 to 1 times the tread width LB, with the second shoulder region (A) extending in each case up to the end of the two-part region of the protector (4).

6. A pneumatic vehicle tyre in accordance with claim 5, characterised in that the waves of the interface (8) have an approximately sinusoidal form in the first shoulder region (B) and approximately a trapezoidal form in the second shoulder region (A) and the central region (C), wherein the wavelength (1) in the second shoulder region (A) and the central region (C) is preferably larger than in the first, approximately sinusoidally shaped shoulder region (B).

7. A pneumatic vehicle tyre in accordance with claim 5, characterised in that the smallest thickness (d) of the lower part of the protector (6) is different in the three regions (A,B,C) and preferably amounts in the middle region (C) to approximately 1.5mm, in the first shoulder region (B) to approximately 2.5mm and in the second shoulder region (A) to approximately 1mm.

8. A pneumatic vehicle tyre in accordance with any one of the preceding claims, characterised in that the upper part of the protector (7) has a dynamic modulus E* of approximately 5 to 8 MPa and a Shore hardness of approximately 60 to 75 ShA and in that the lower part of the protector (6) has a dynamic modulus E* of approximately 4 to 7 MPa and a Shore hardness of approximately 55 to 65 ShA.

Fig.1

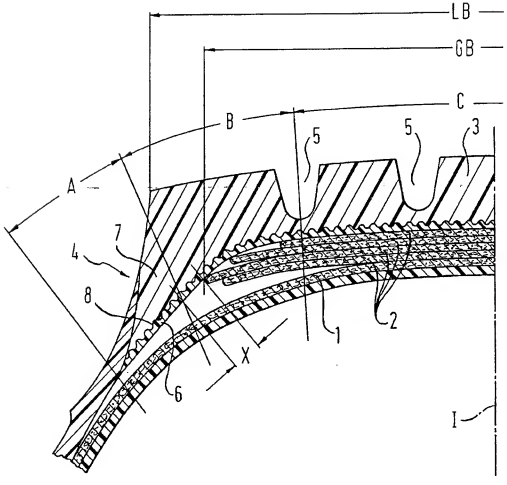


Fig. 2

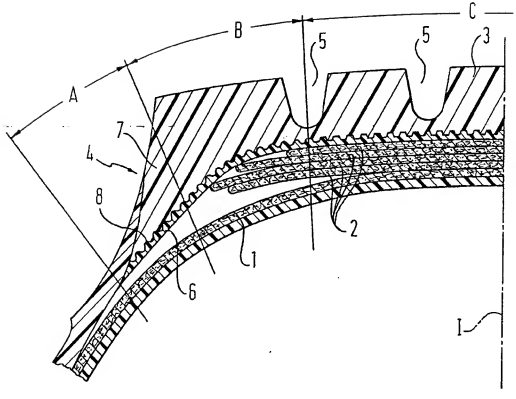


Fig.3

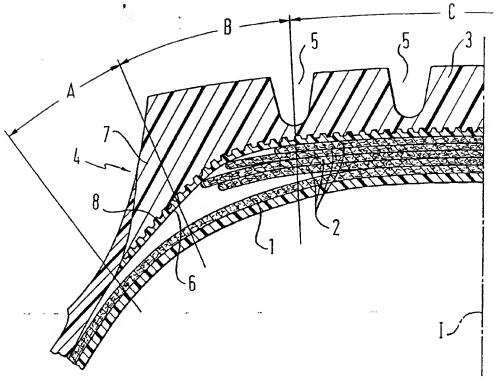
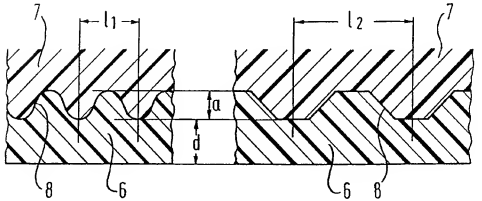



Fig.4



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# EUROPEAN SEARCH REPORT

Application Number
EP 95 30 3724

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X | EP-A-0 104 133 (THE GOODYEAR TIRE&RUBBER CO.)<br>* page 5, line 27 - page 6, line 22; claims; figures *<br>--- | 1,3 | B60C11/00<br>B60C1/00 |
| X | DE-A-23 62 627 (CONTINENTAL)<br>* page 3, paragraph 2; claims; figures *<br>--- | 1,2 | |
| X | DE-A-19 01 448 (DUNLOP LTD.)<br>* page 5; claims; figures *<br>--- | 1,2,4 | |
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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B60C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 28 September 1995 | Baradat, J-L |

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